DAO cloud-clearing, systematic error correction, cloud height determination, monitoring, and results using TOVS data

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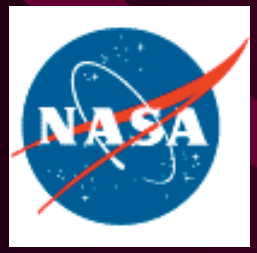


Outline

- DAOTOVS variational cloud-clearing
- Systematic error correction
- Results with TOVS
- Radiance/retrieval monitoring
- Dynamic channel selection based on cloud height
- Summary

Analysis Equation

- $w_a = w_f + BH' [HBH' + (O+F)]^{-1} [y - h(w_f)]$
- Where
  - w_a is the analysis state
  - w_f is the forecast or background state (1st guess)
  - B is the background error covariance
  - O, F are observation, forward model error covariance
  - h, H are the observation operator and Jacobian
  - y are the observations

DAOTOVS 1DVAR system

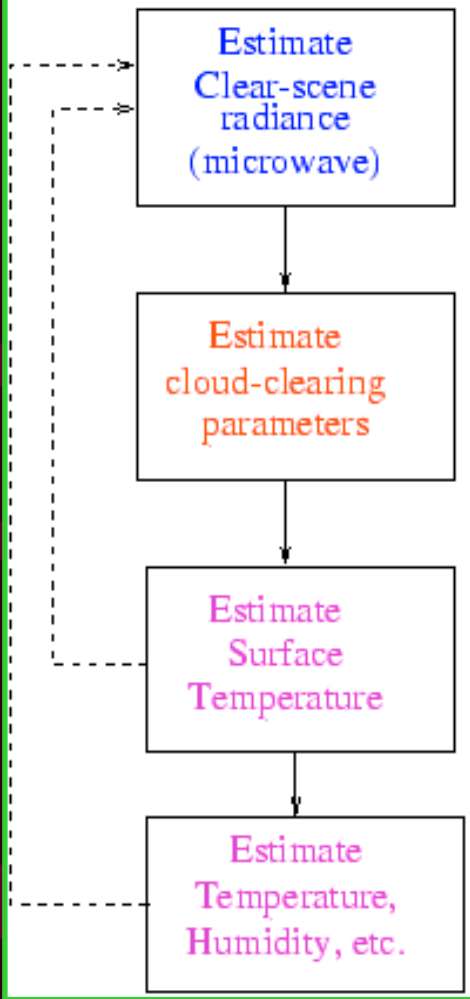
- Uses raw (level 1b) data
- Variational cloud-clearing (Joiner and Rokke, 2000); eigen-vector FOV determination (AIRS ATBD)
- Physically-based systematic error correction (tuning)
- Forward models: GLATOVS, MIT -> OPTRAN (NASA/NOAA collaboration)
- Runs in operational GEOS-DAS and next-generation Finite-volume DAS (FVDAS), currently running in parallel system

DAOTOVS: What makes it different?

- Uses cloud- and land-affected data. Currently running full impact studies to see if we get positive impact from these data
- Radiosonde shadowing: check for nearby sondes and mark nearby TOVS data as passive.
- Tuning using collocated radiosondes (not background). Updated daily.

Cloud-clearing implementation

Previous Implementations

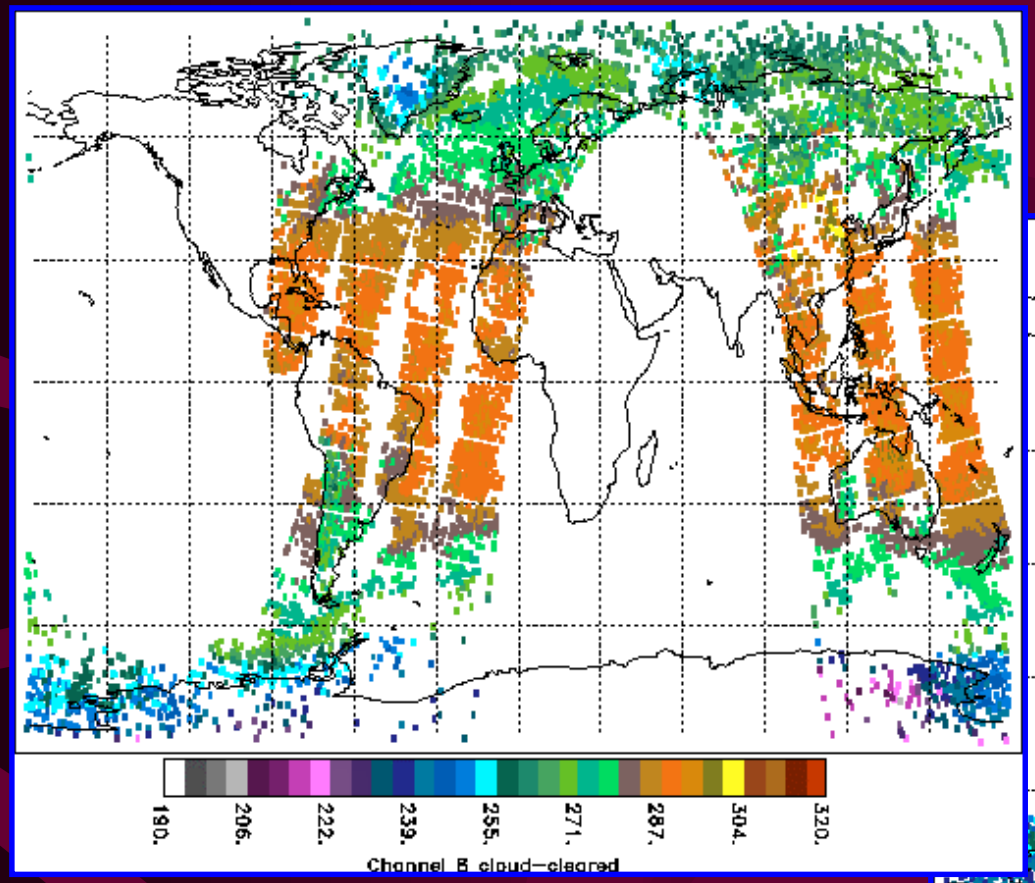


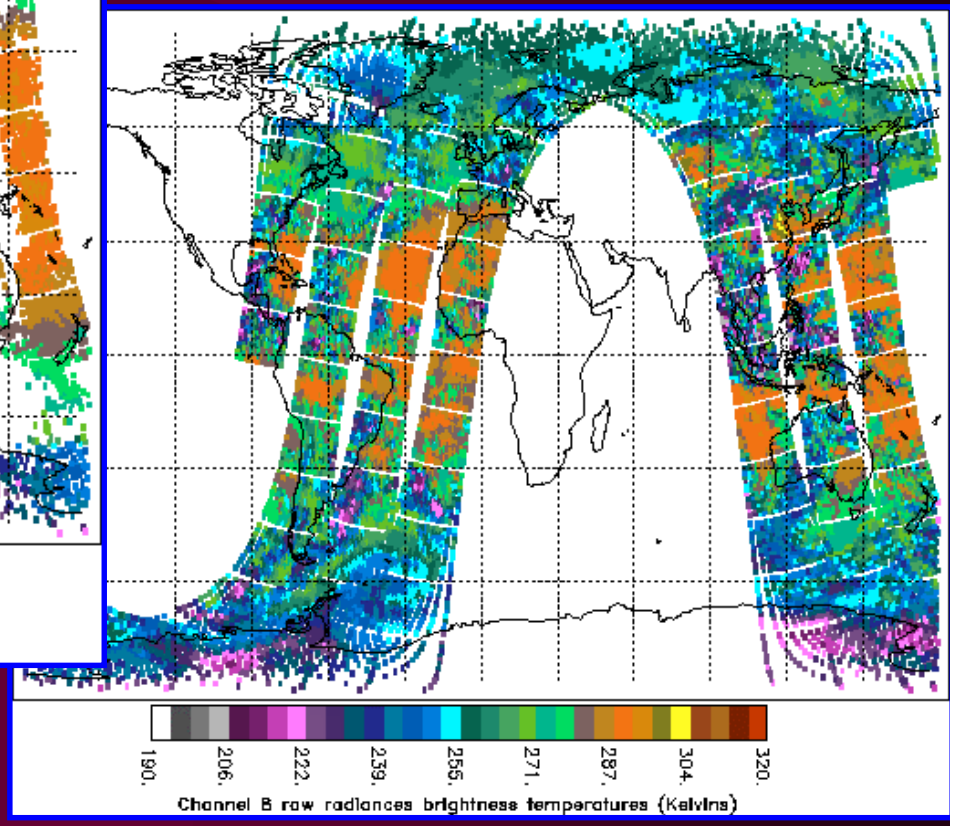
New Implementation

Variational approach
using all channels
to simultaneous estimate
cloud-clearing parameters
and atmospheric and
surface parameters

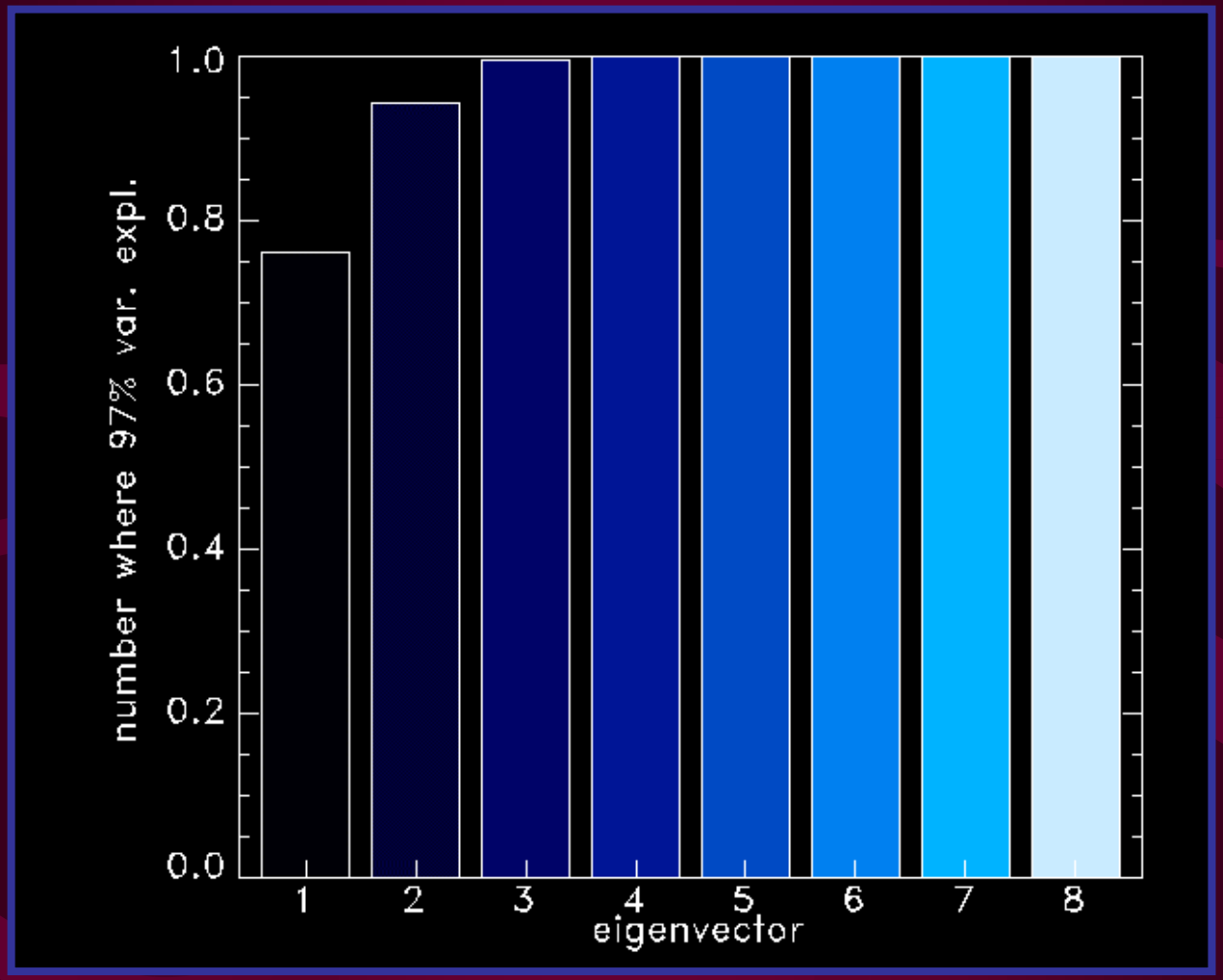
1. Simplicity
2. Consistency
3. Quality Control Built in
4. Physically-based systematic error correction

HIRS window channel, observed and cloud-cleared



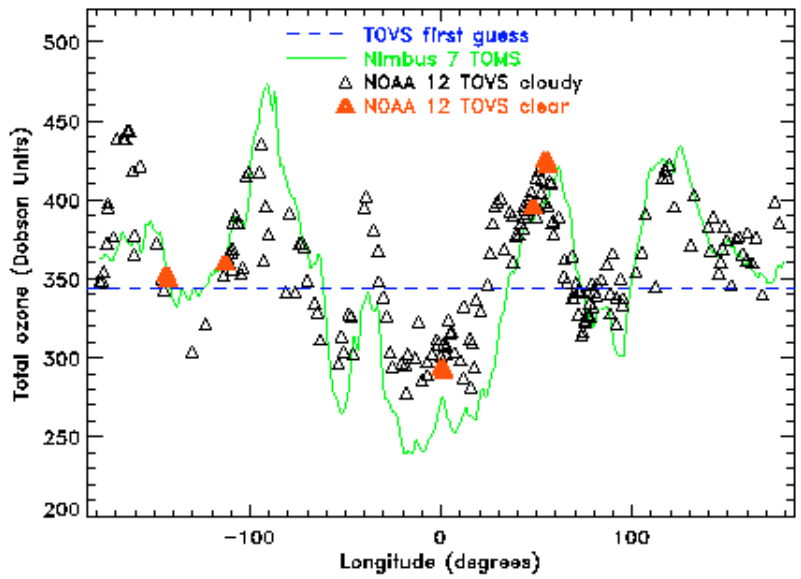


How many eigen-vectors do you need for cloud-clearing? NOAA-K data

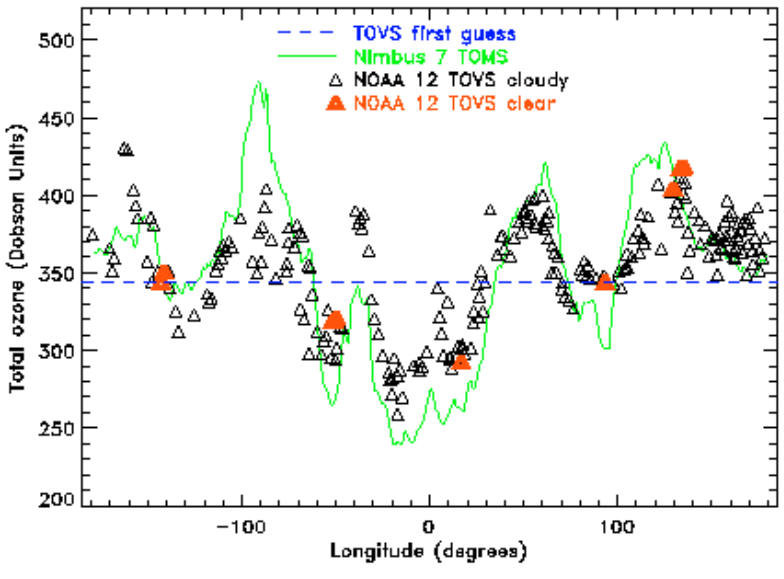


1DVAR validation: Ozone comparison with TOMS

NOAA 12



NOAA 11



Cloud detection

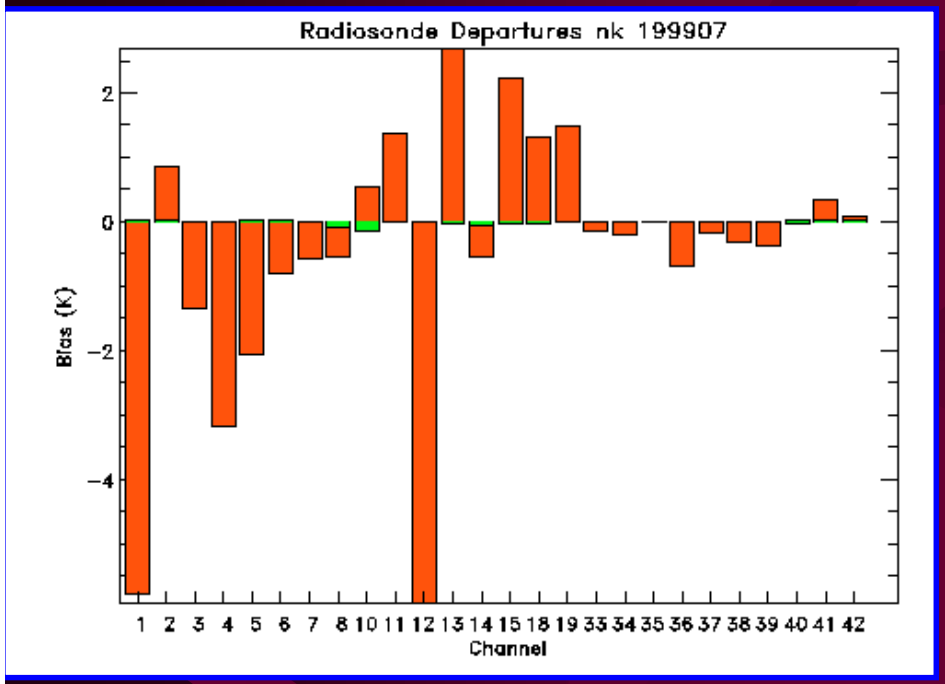
- Background window channel check (Derber and Wu) |O-F(HIRS8)|<1K sea, <3K land
- Albedo check from VIS channel and frozen sea test (McMillin and Dean)
- Long-wave/short-wave consistency checks (Eyre, McMillin and Dean)
- FOV homogeneity check (if passes, average all FOVs)
- Currently working on microwave/IR consistency check for AIRS/AMSU
- Less that 10% found clear, less than half of those clear in all 3 FOVs

DAOTOVS systematic error correction

- Bias predictors include constant, γ_{fix}, γ_{H2O}, θ, sec(θ)
- Use collocated radiosondes (background above raob levels), eliminate certain types with known bias
  - Limits forecast bias
  - Cloud-detection for tropospheric channels
  - Radiosondes reaching 30 hPa for stratospheric channels (do not tune channels peaking above raobs, ex. AMSU 13-14, SSU)
  - QC applied to radiosondes
  - < 100 soundings /day meet criteria
- Use Kalman Filter for estimating tuning coefficients
  - Updated daily
  - Errors in parameters estimated and carried
  - Stabilizes quickly and prevents rapid changes, but able to adjust to slowly changing instrument
- Estimate surface parameters simultaneously (ε_{mw}, Ts, ρ)

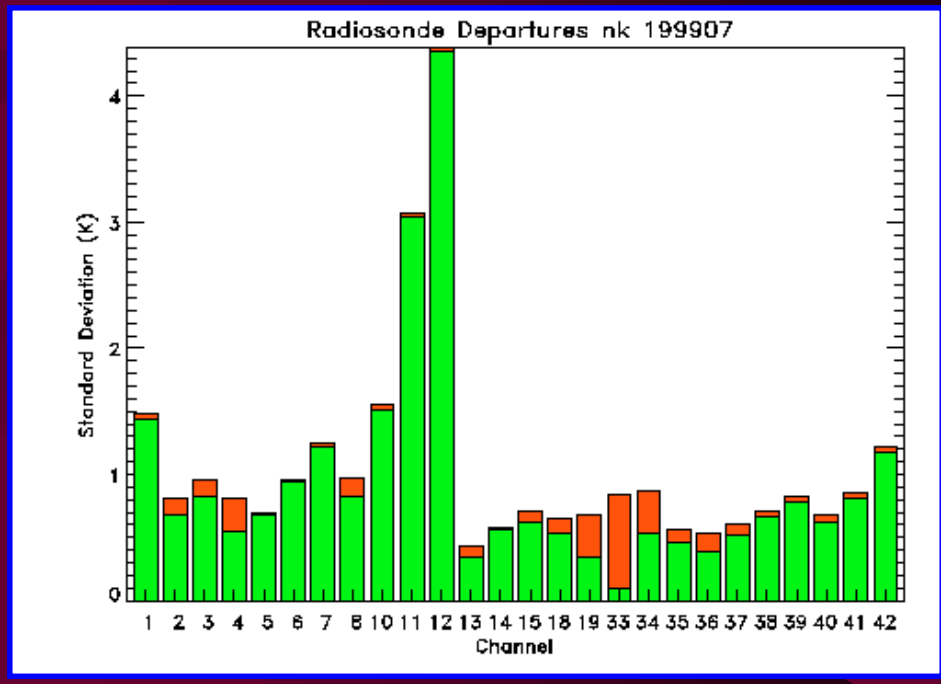
Ex. NOAA-15 tuning, Sept 1999
Red:before tuning; Green:after tuning

Bias



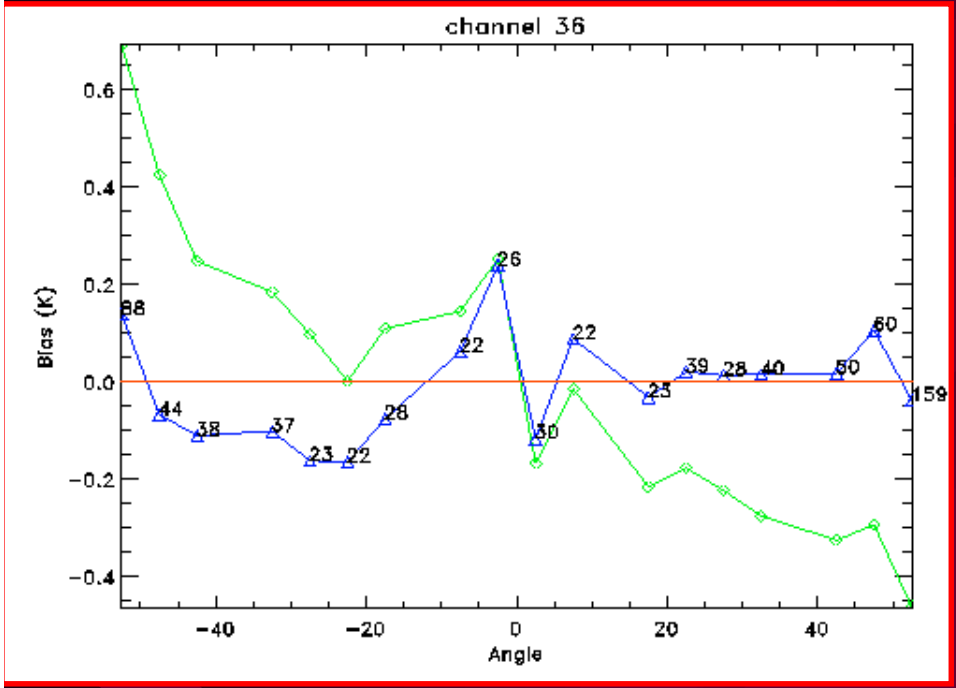
HIRS/3 AMSU

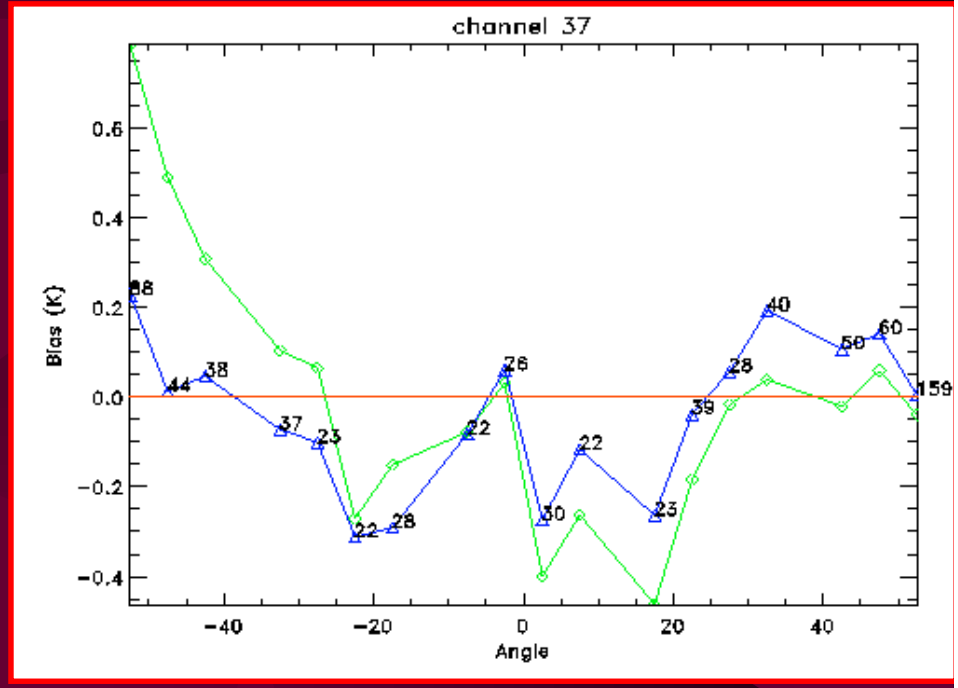
Standard Deviation



HIRS/3 AMSU

Scan-angle-dependent biases in AMSU, green:before tuning, blue: after tuning

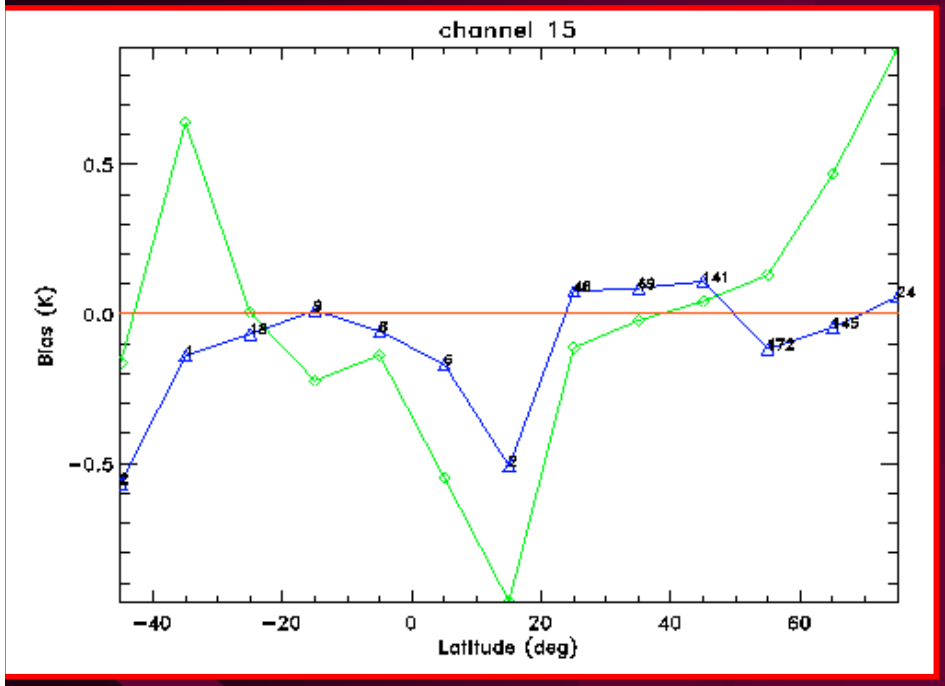




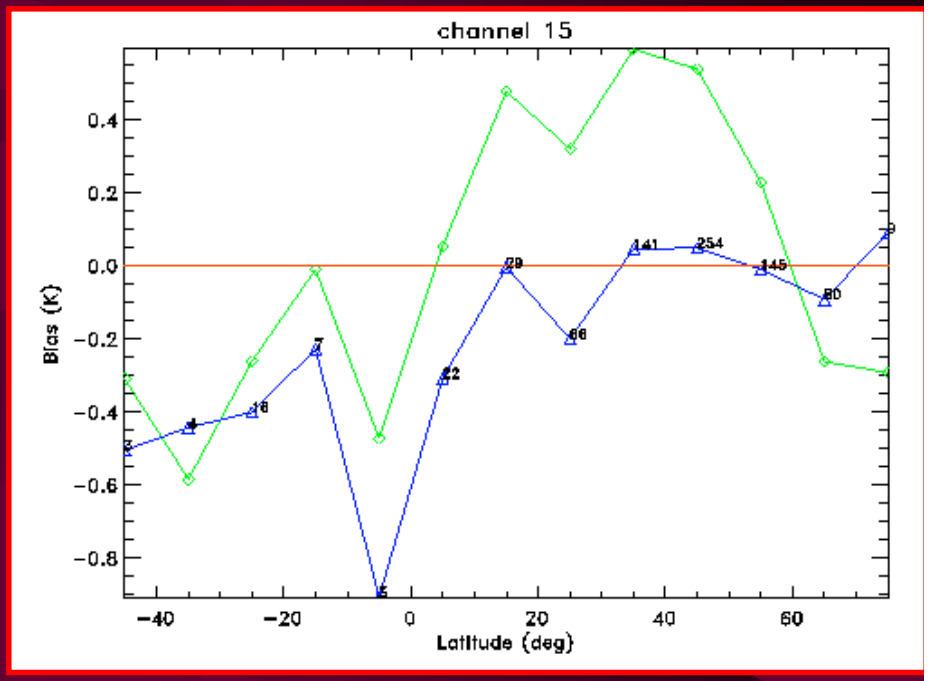
Latitude-dependence of Bias, HIRS-15

Green:before tuning; Blue:after tuning

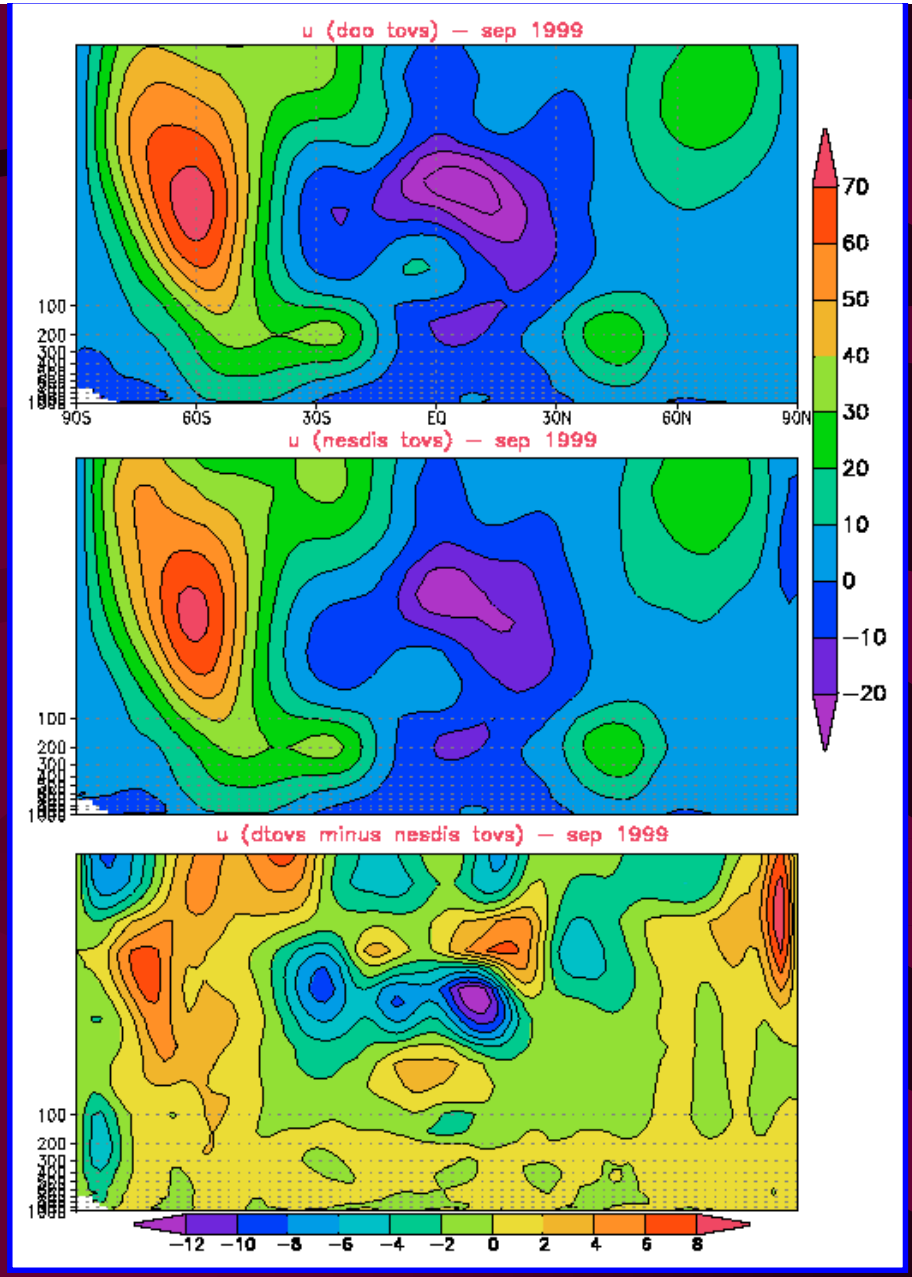
NOAA-14



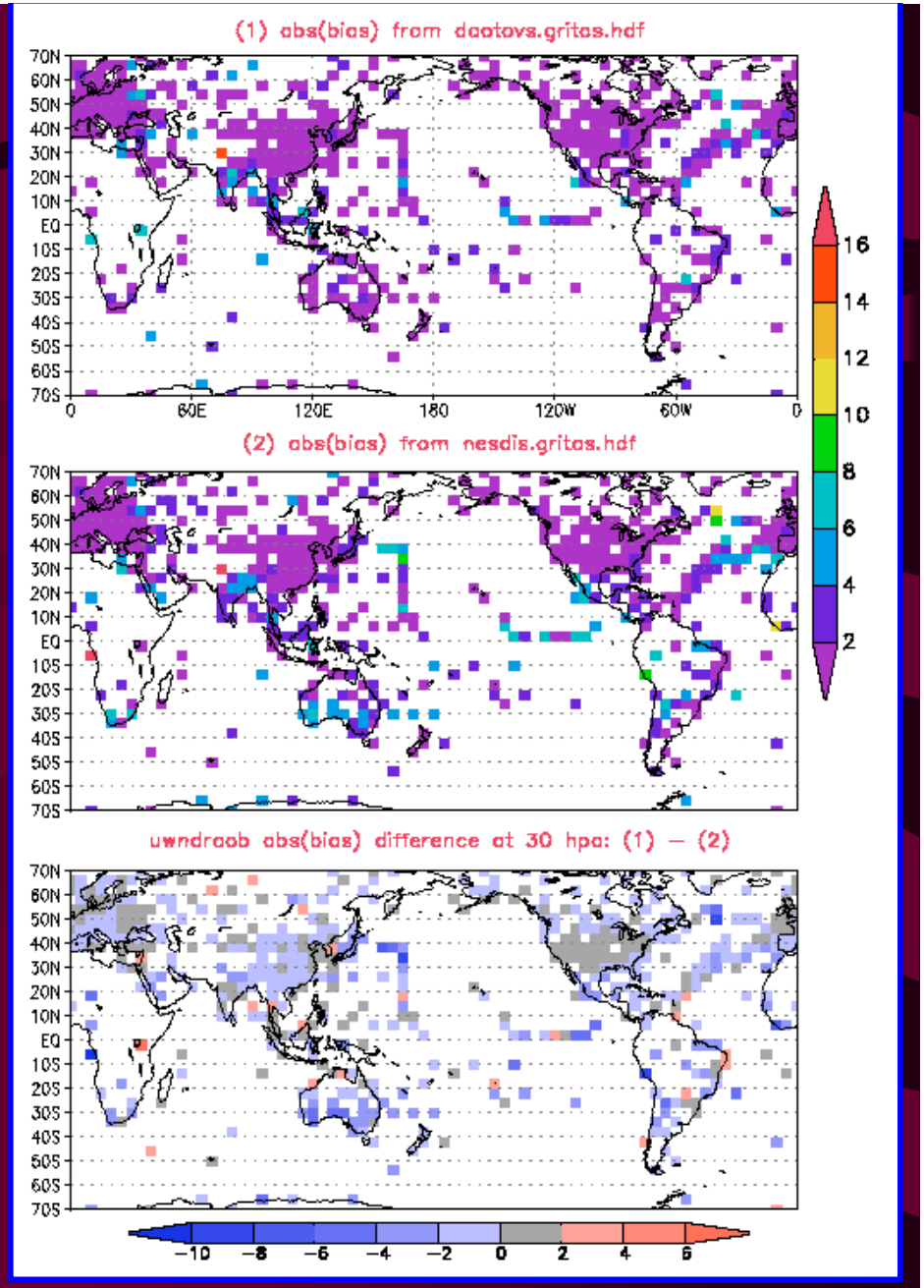
NOAA-15



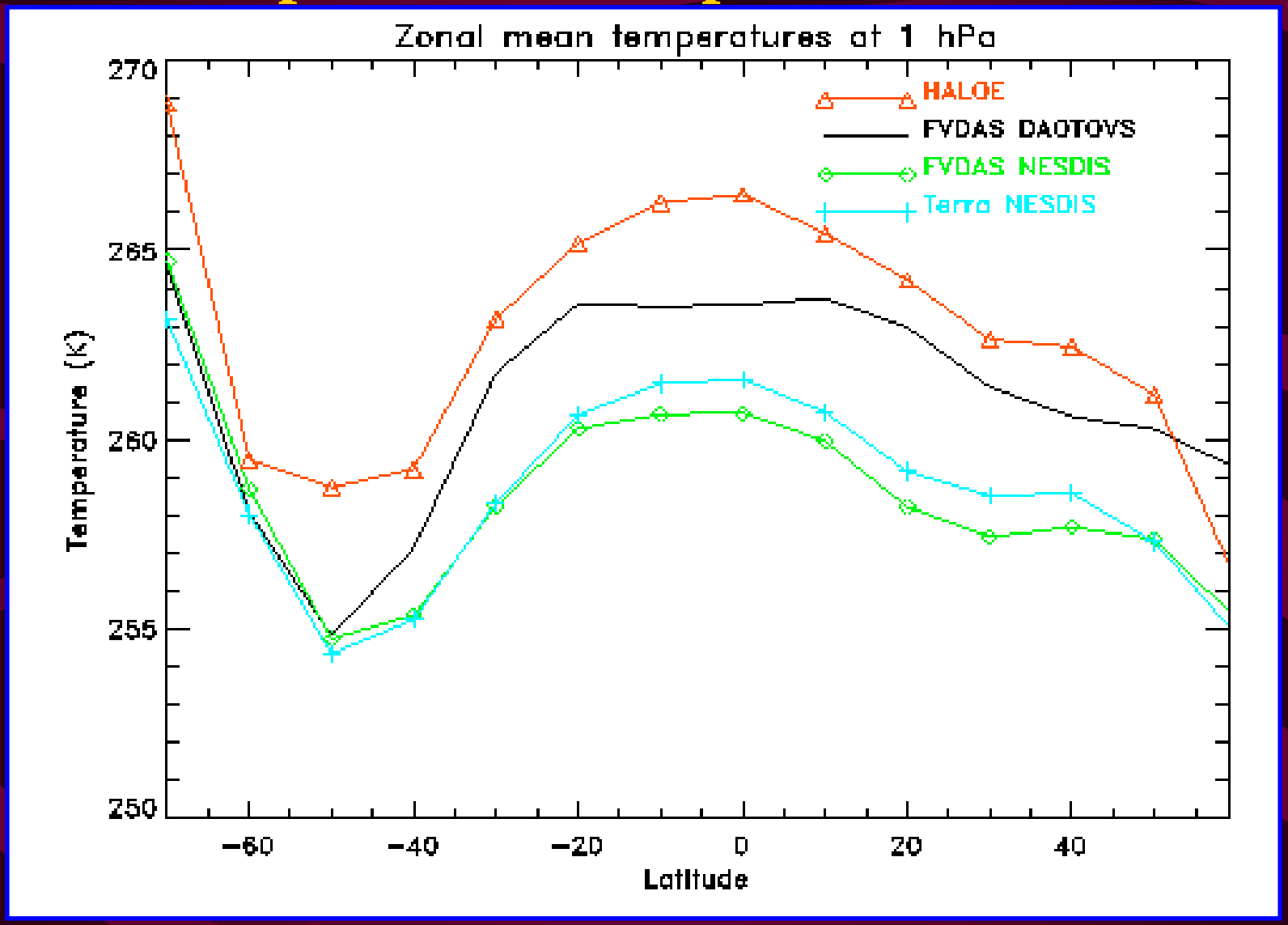
Monthly-mean zonal winds from FVDAS (impact of 1DVAR)



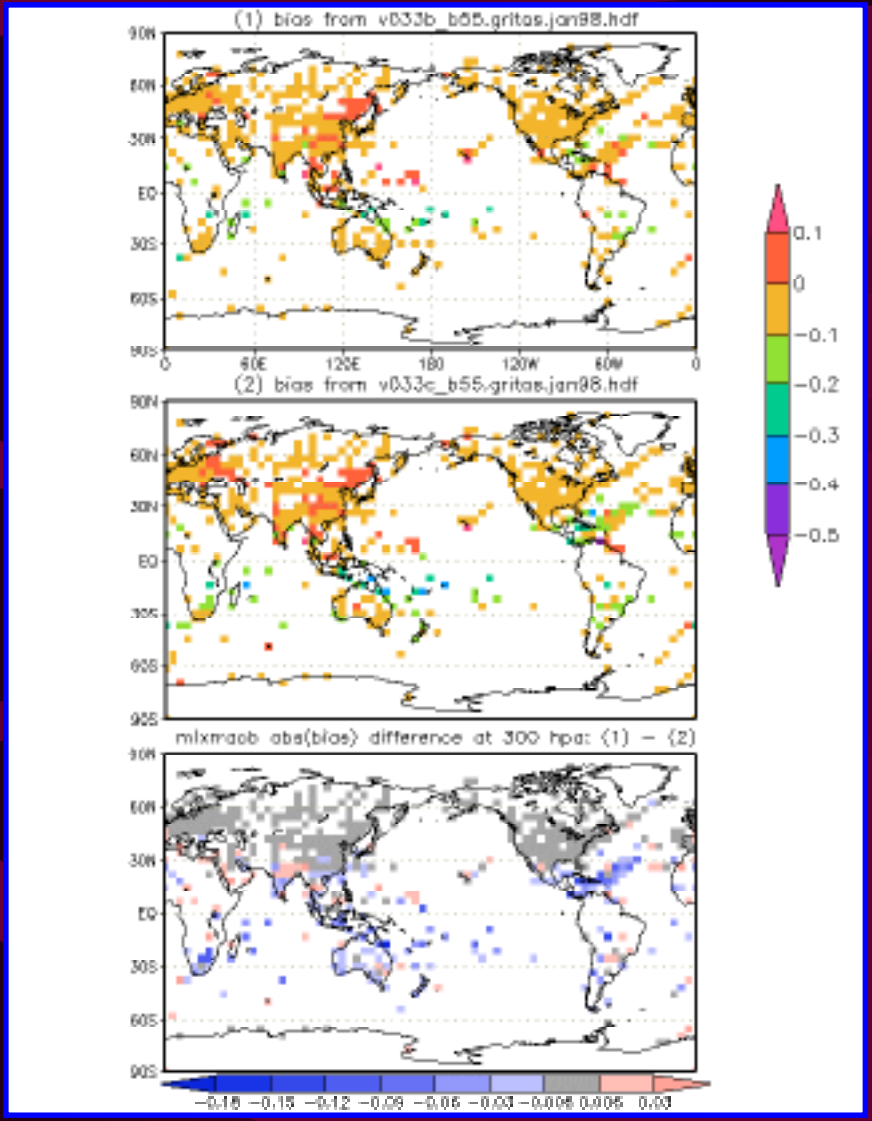
Monthly-mean radiosonde observations – 6 hr forecast zonal wind (blue in bottom panel = improvement with 1DVAR)

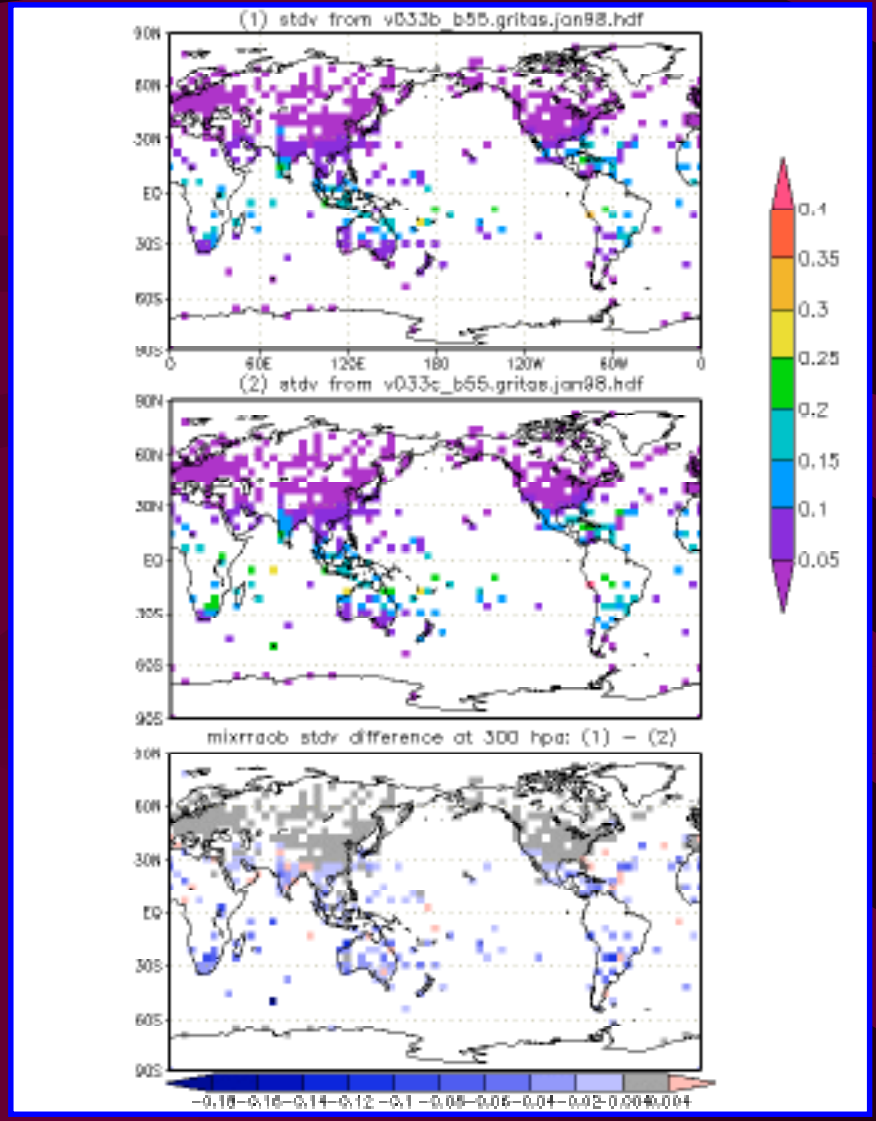


1 hPa Temperatures compared with HALOE



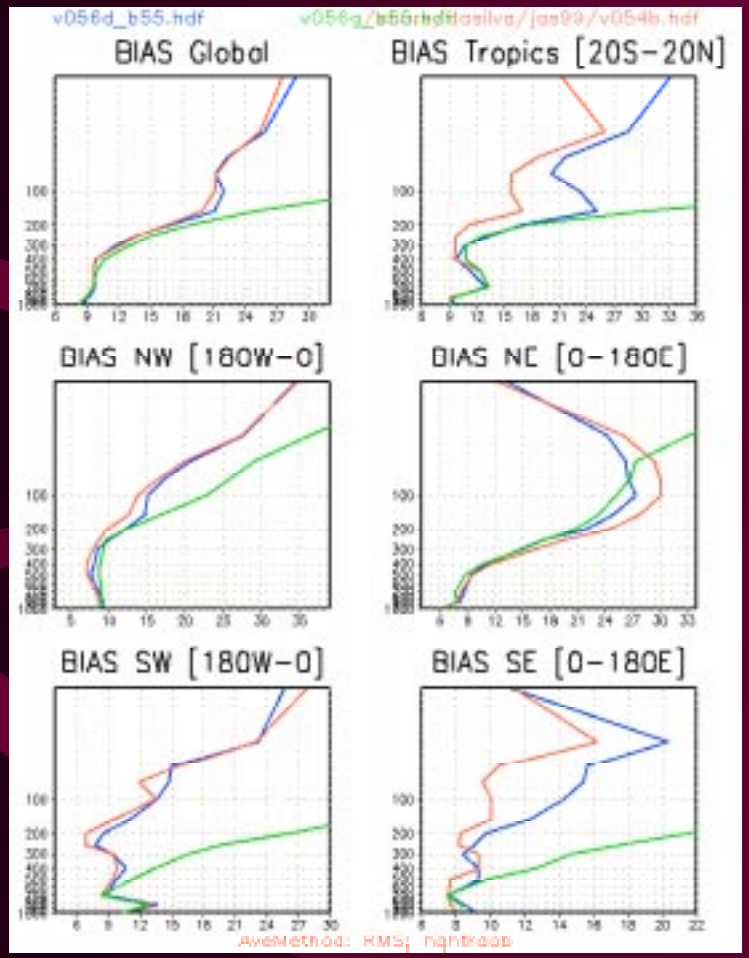
Jan. 1998 radiosonde O-Fs, 300 hPa

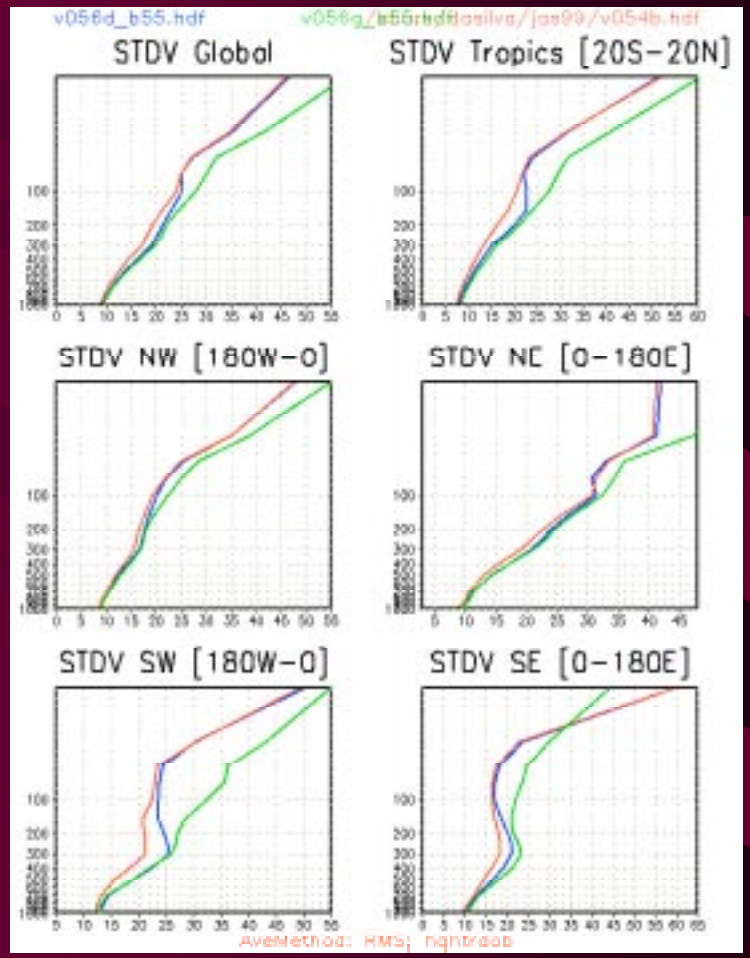




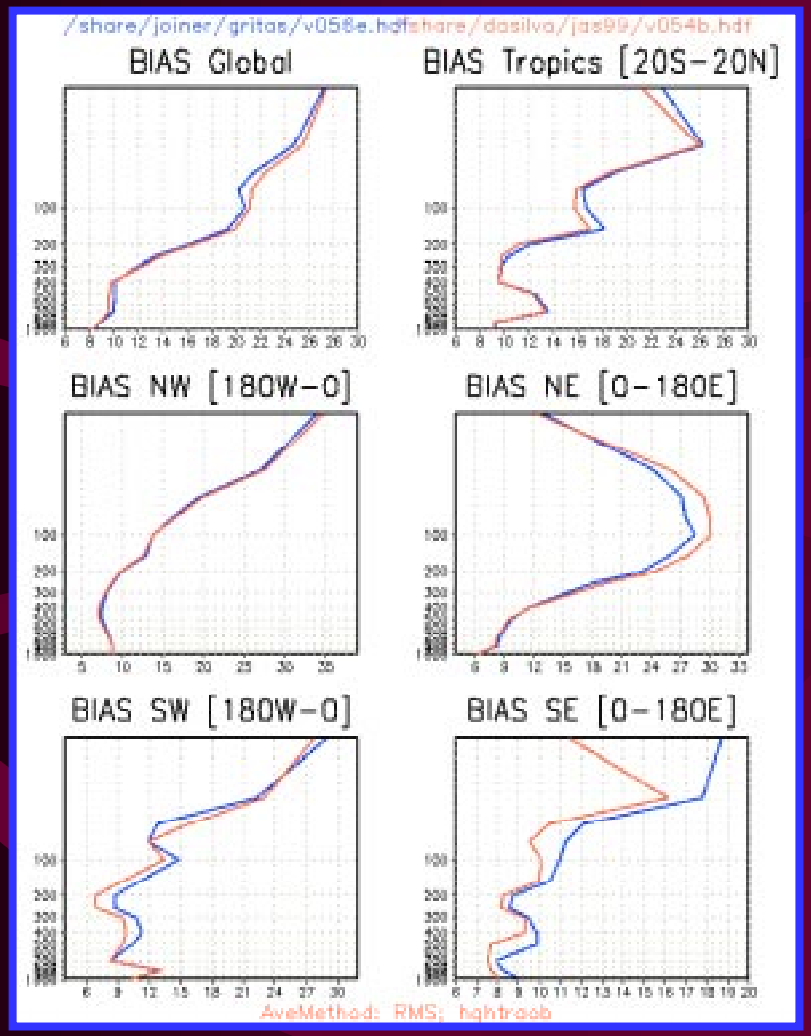
Cloud clearing has positive impact on 6 hour forecast, verified with radiosondes in finite-volume DAS

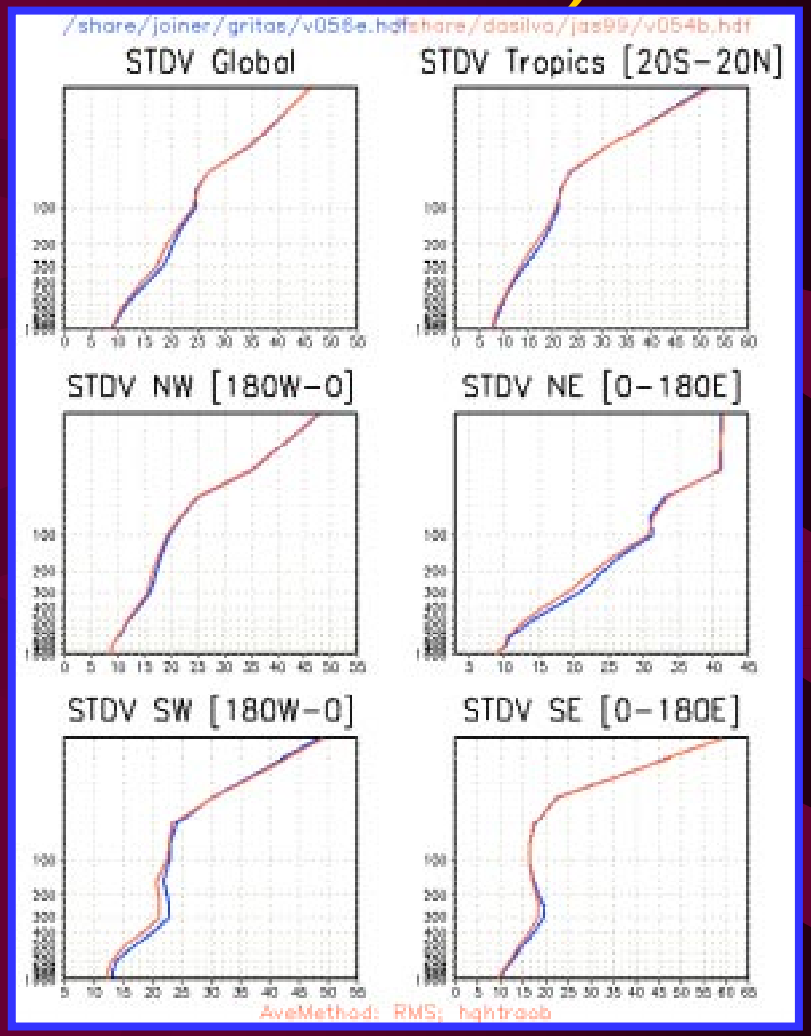
green: NESDIS TOVS, red: DAOTOVS w/cloud-cleared, blue: DAOTOVS, no cloudy



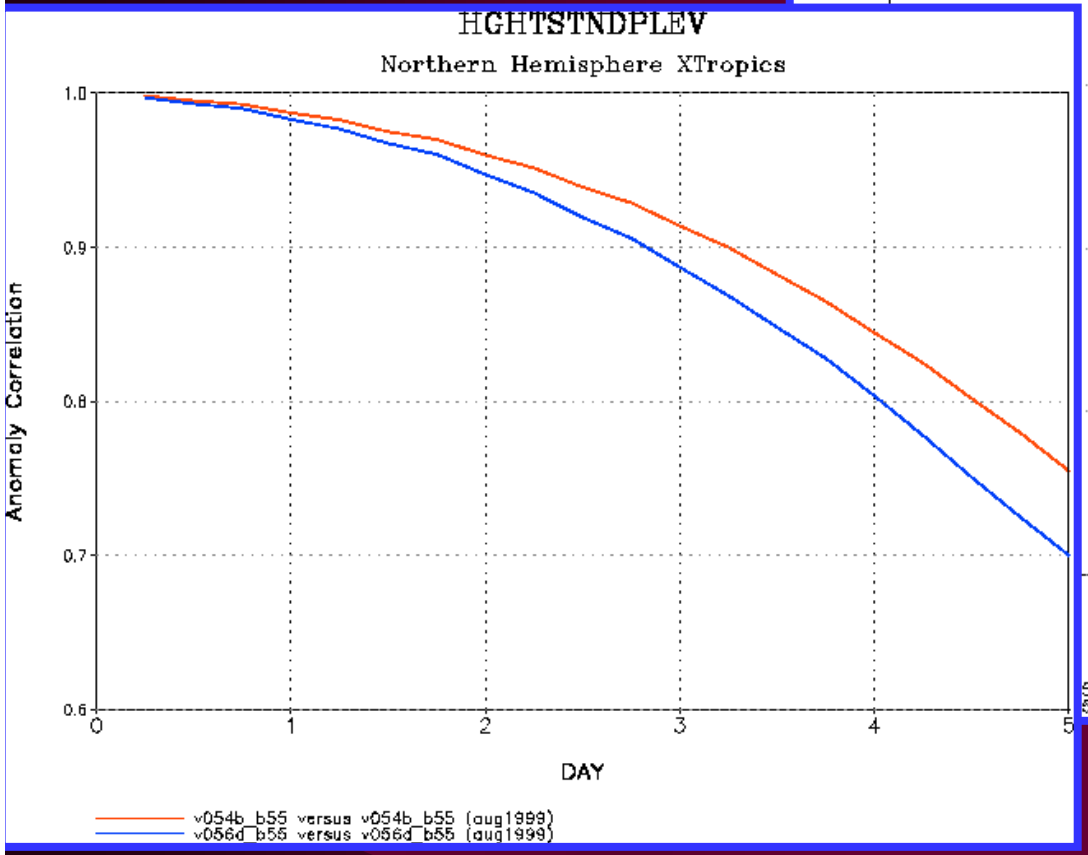


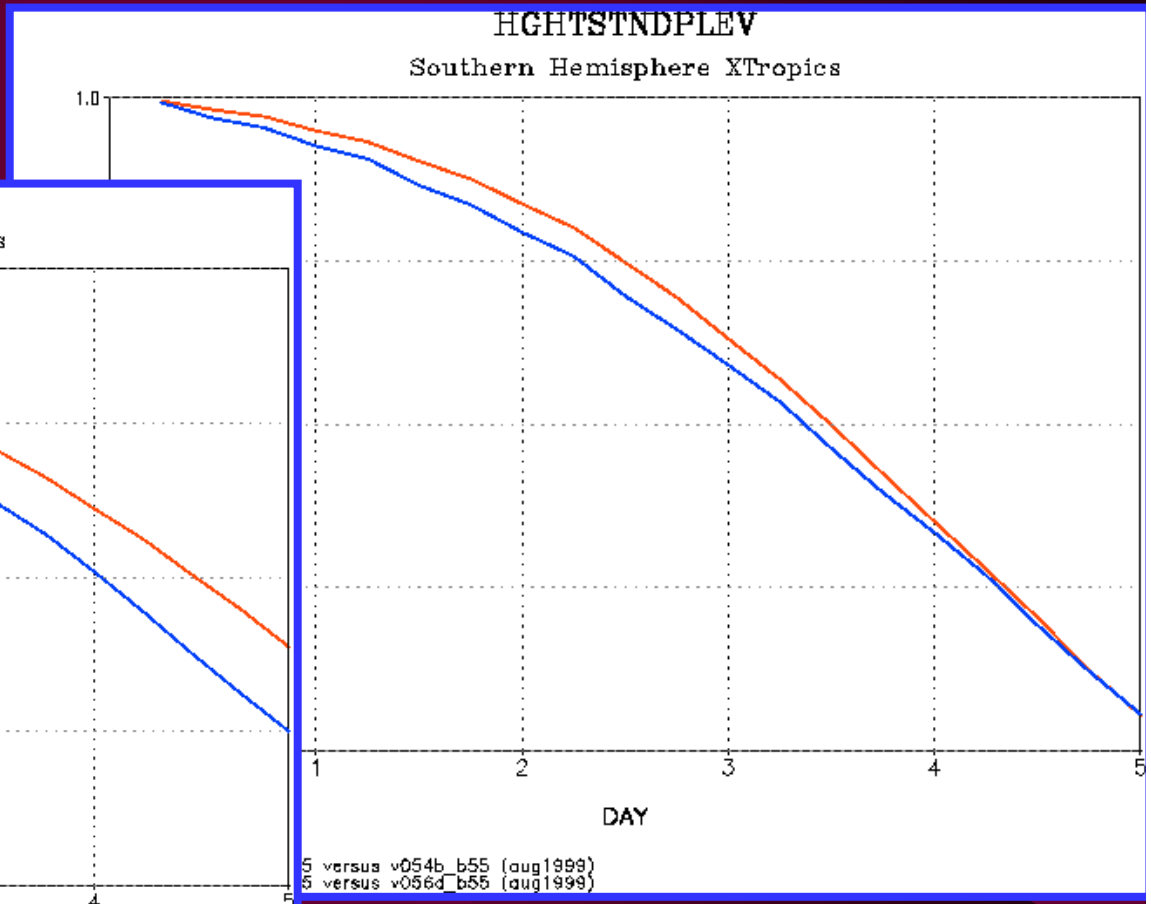
Impact of land-affected data (red-includes land, blue-no land)



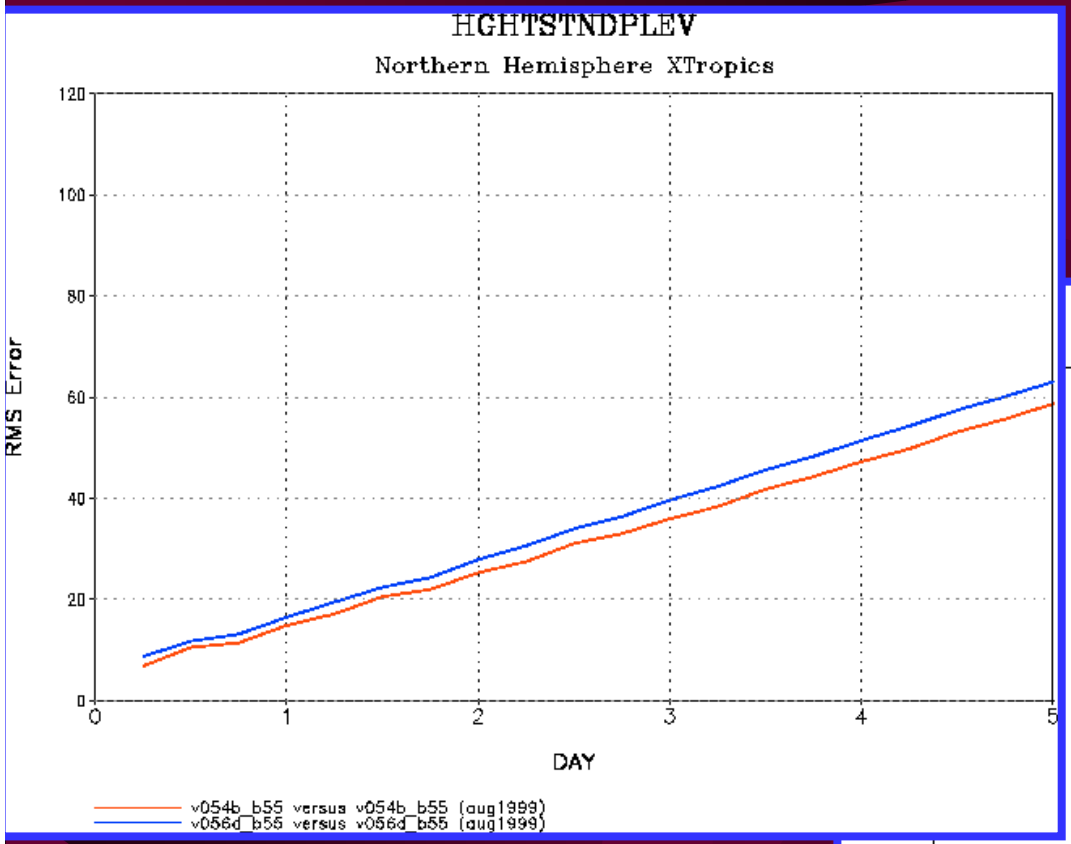


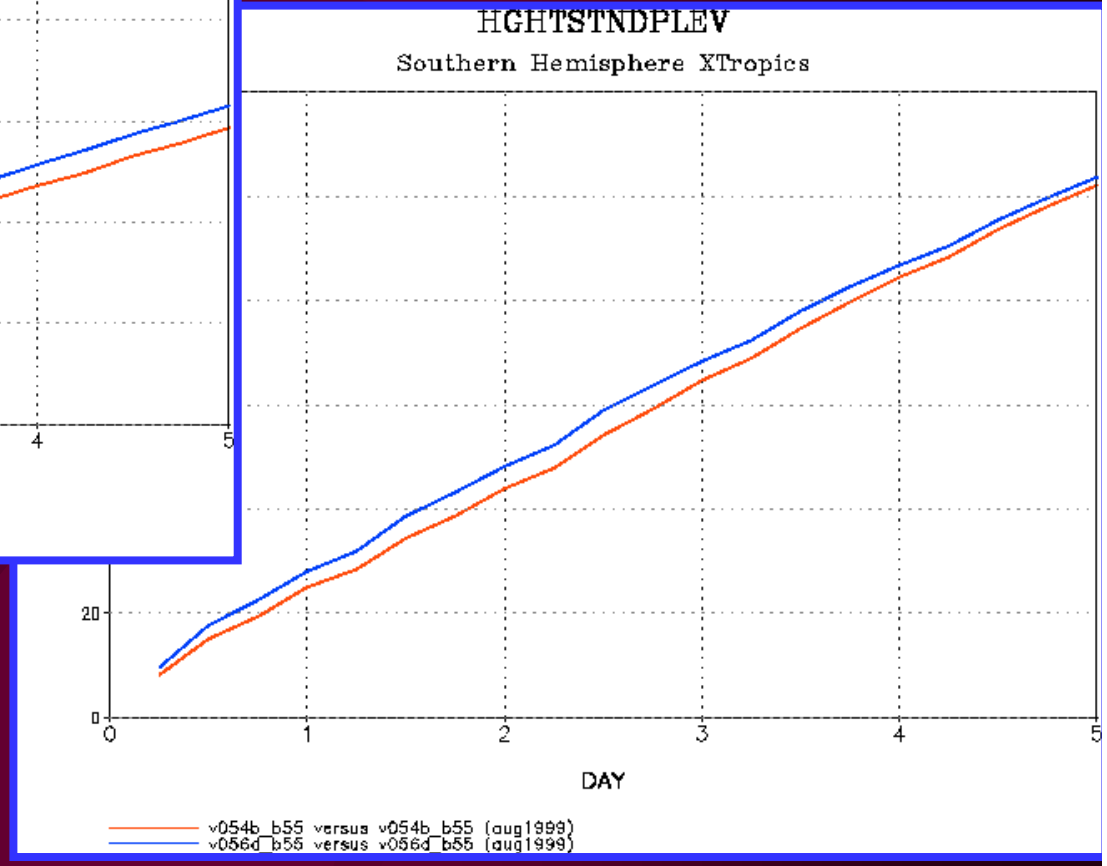
Forecast experiments, red: cloud-cleared, blue: no cloudy



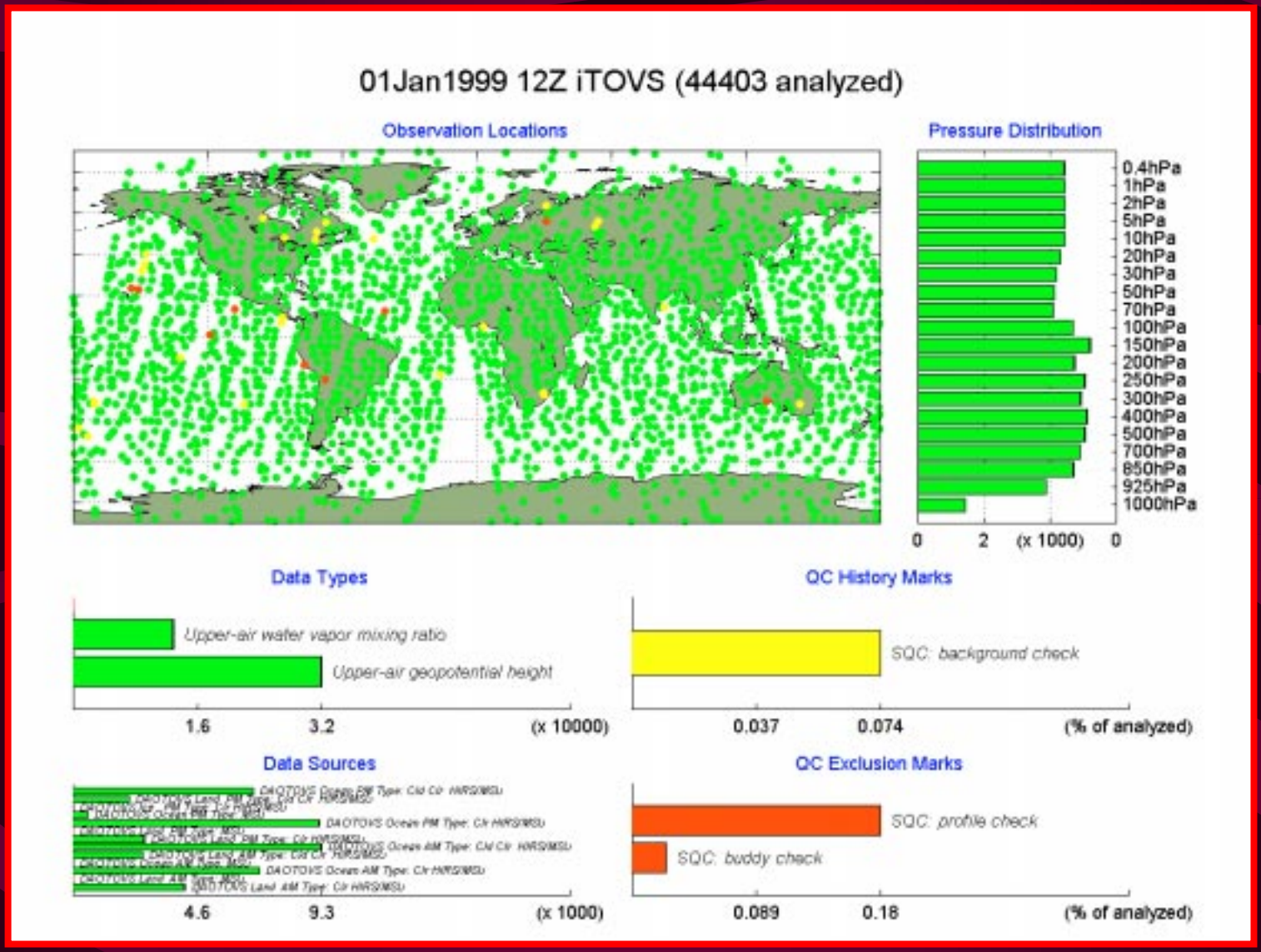


Forecast experiments, red: cloud-cleared, blue: no cloudy

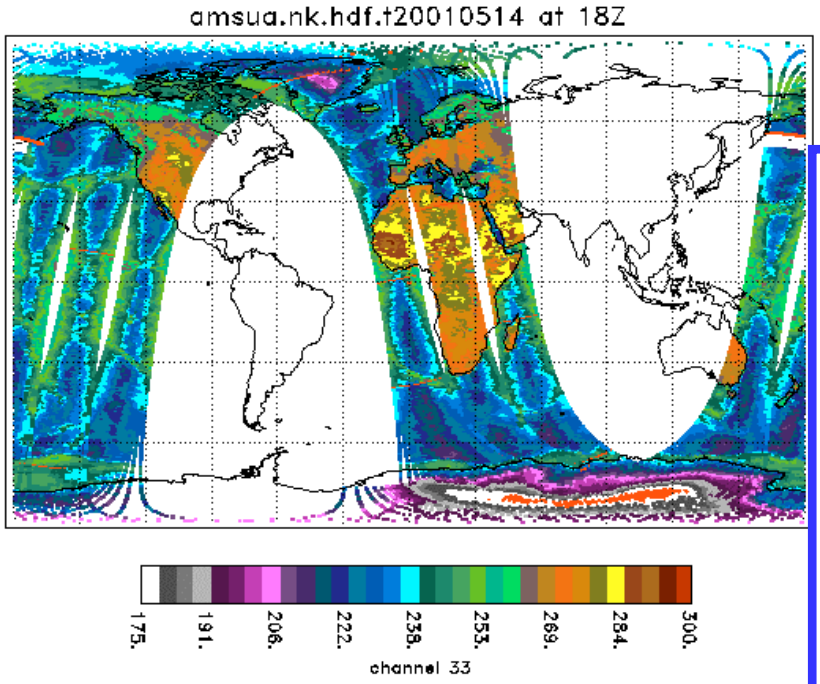


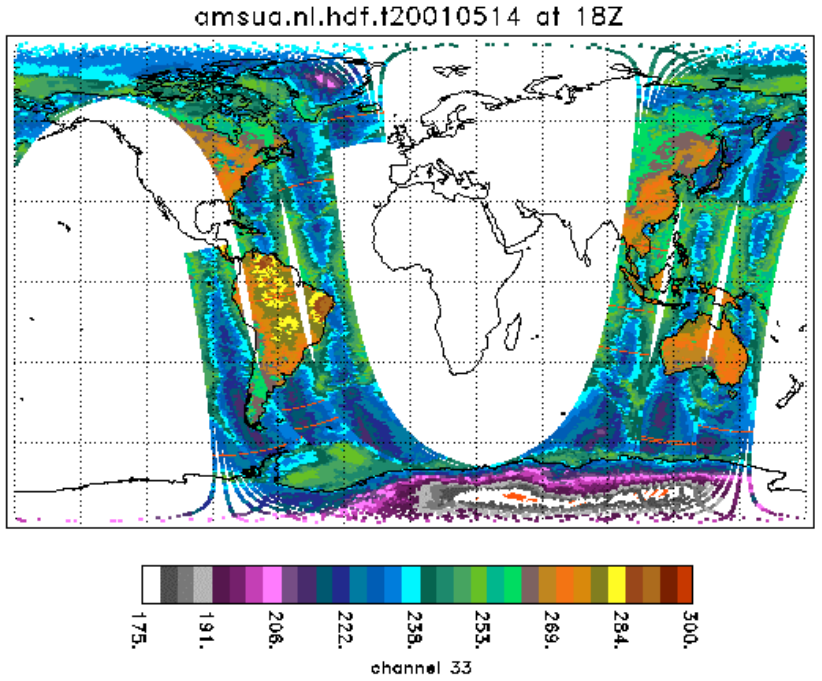


Monitoring: Quality Control Decisions

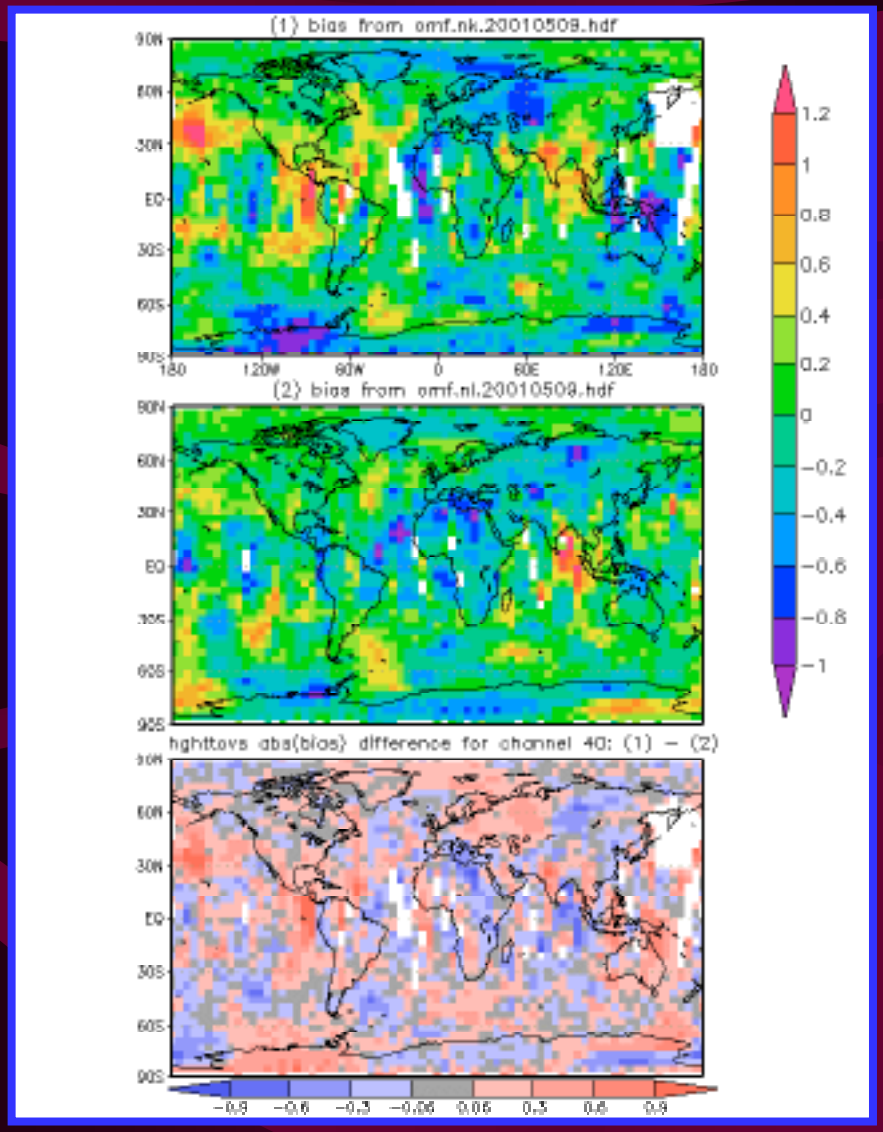


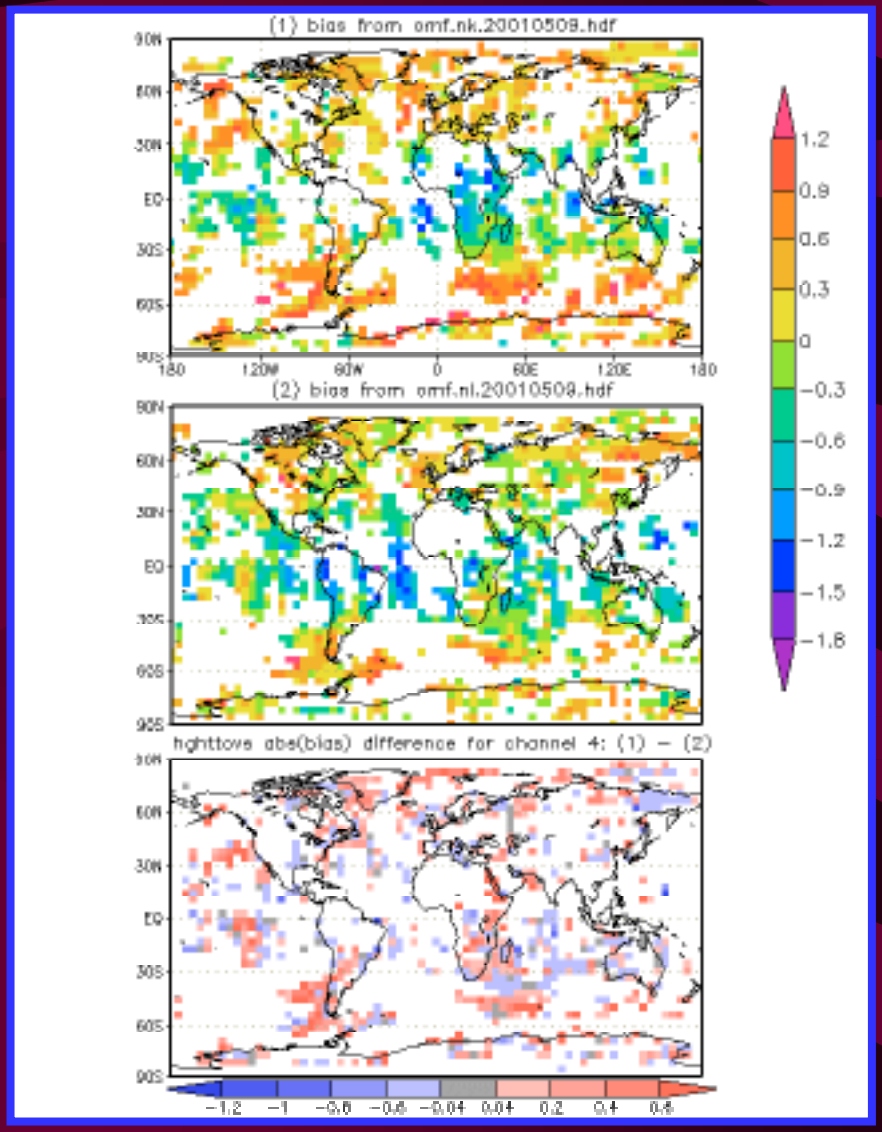
Radiance Monitoring



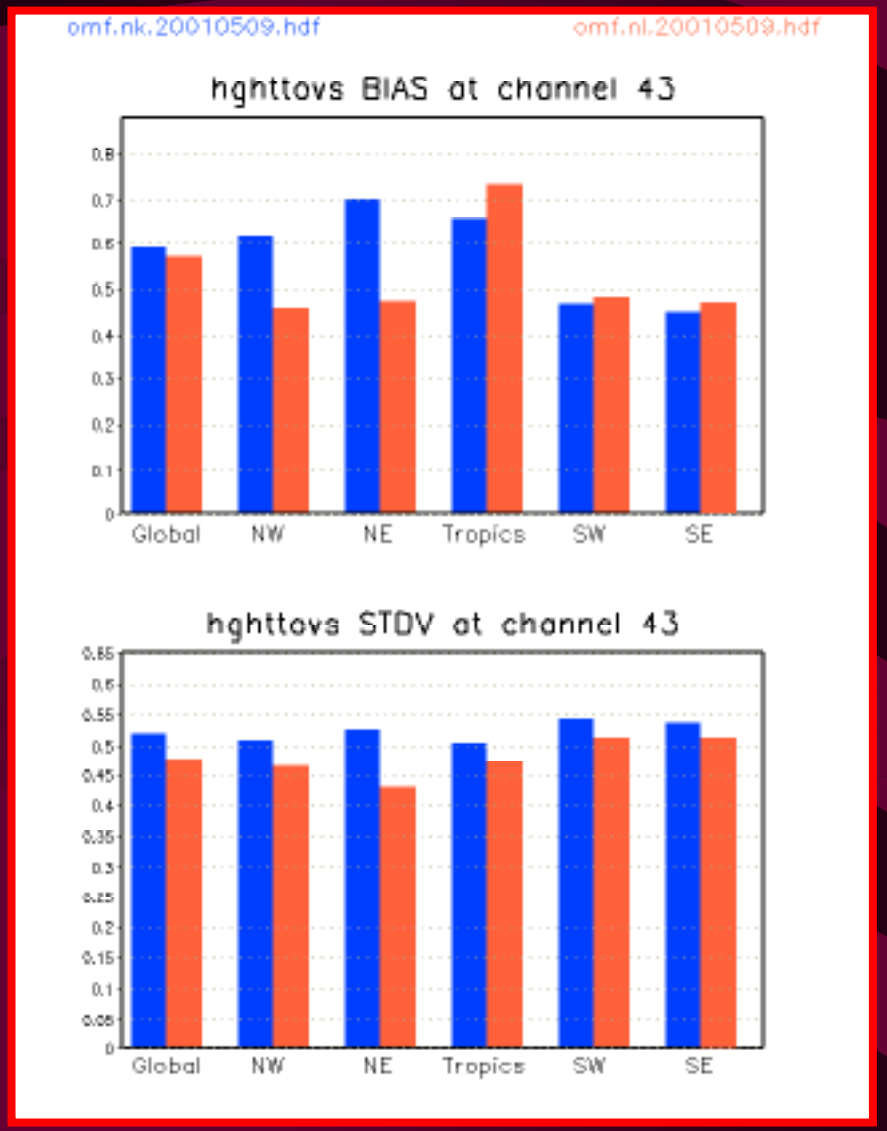


Monitoring radiance O-Fs

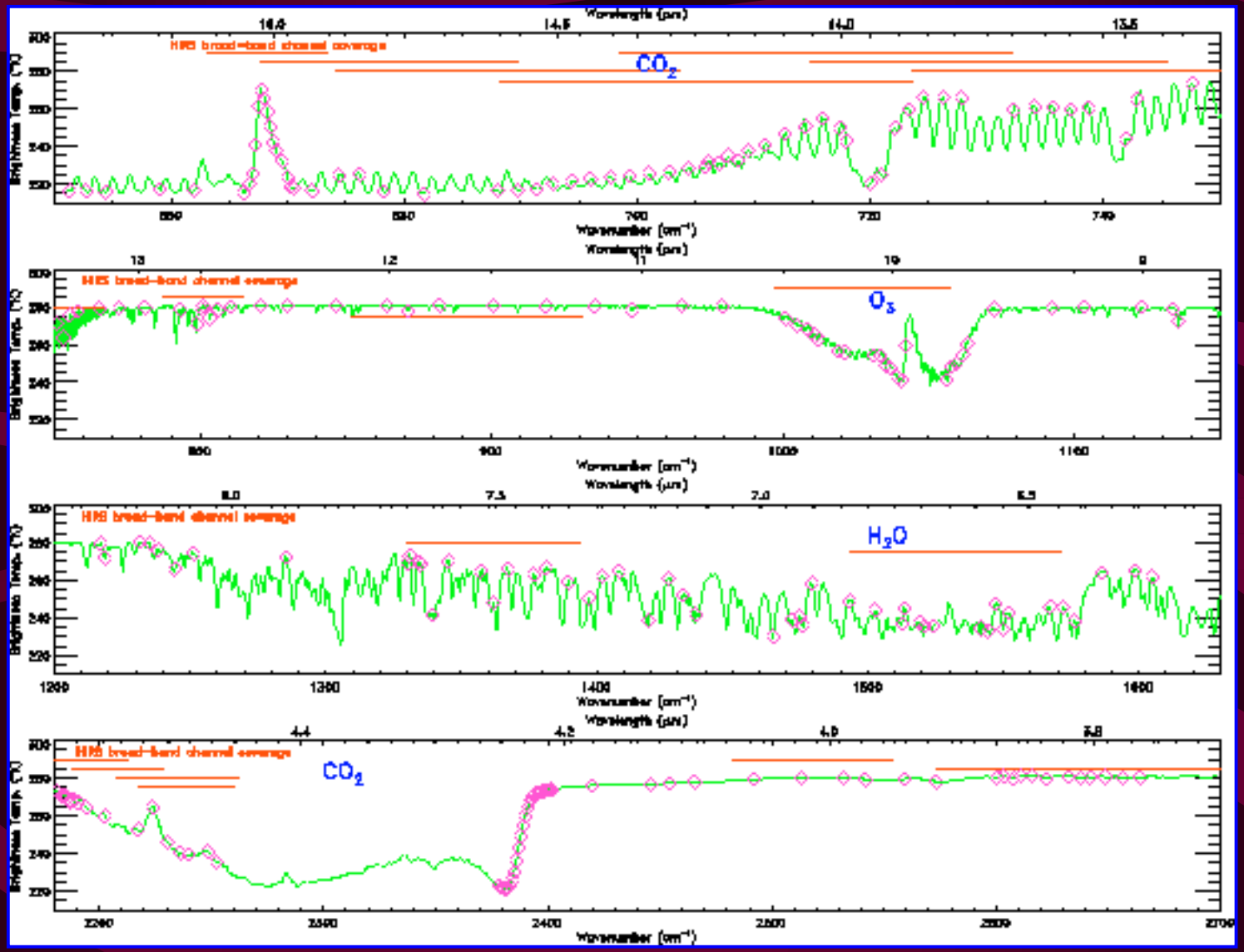




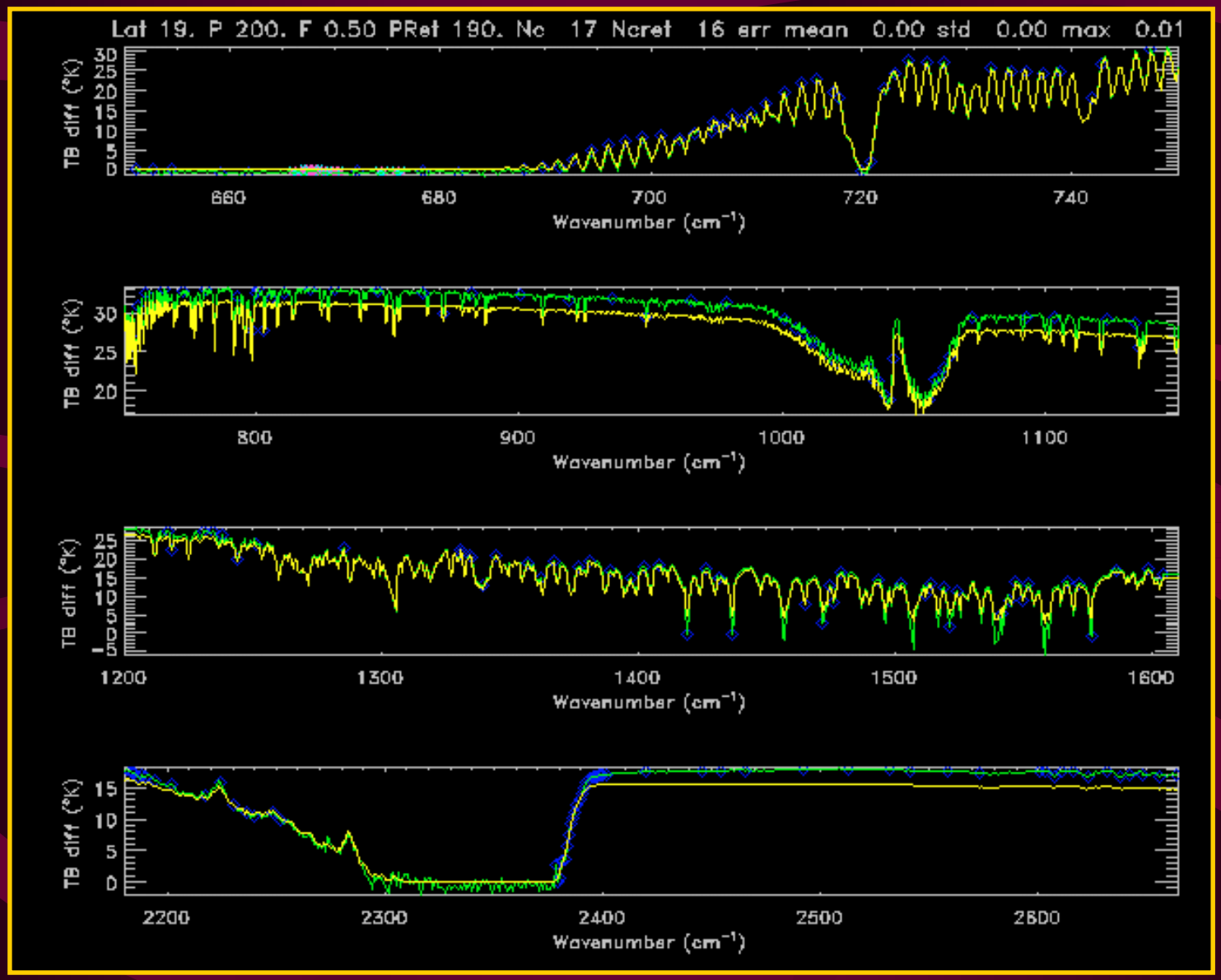
More radiance monitoring options (breakdown by region)



AIRS initial channel selection



Channel selection based on retrieved cloud height



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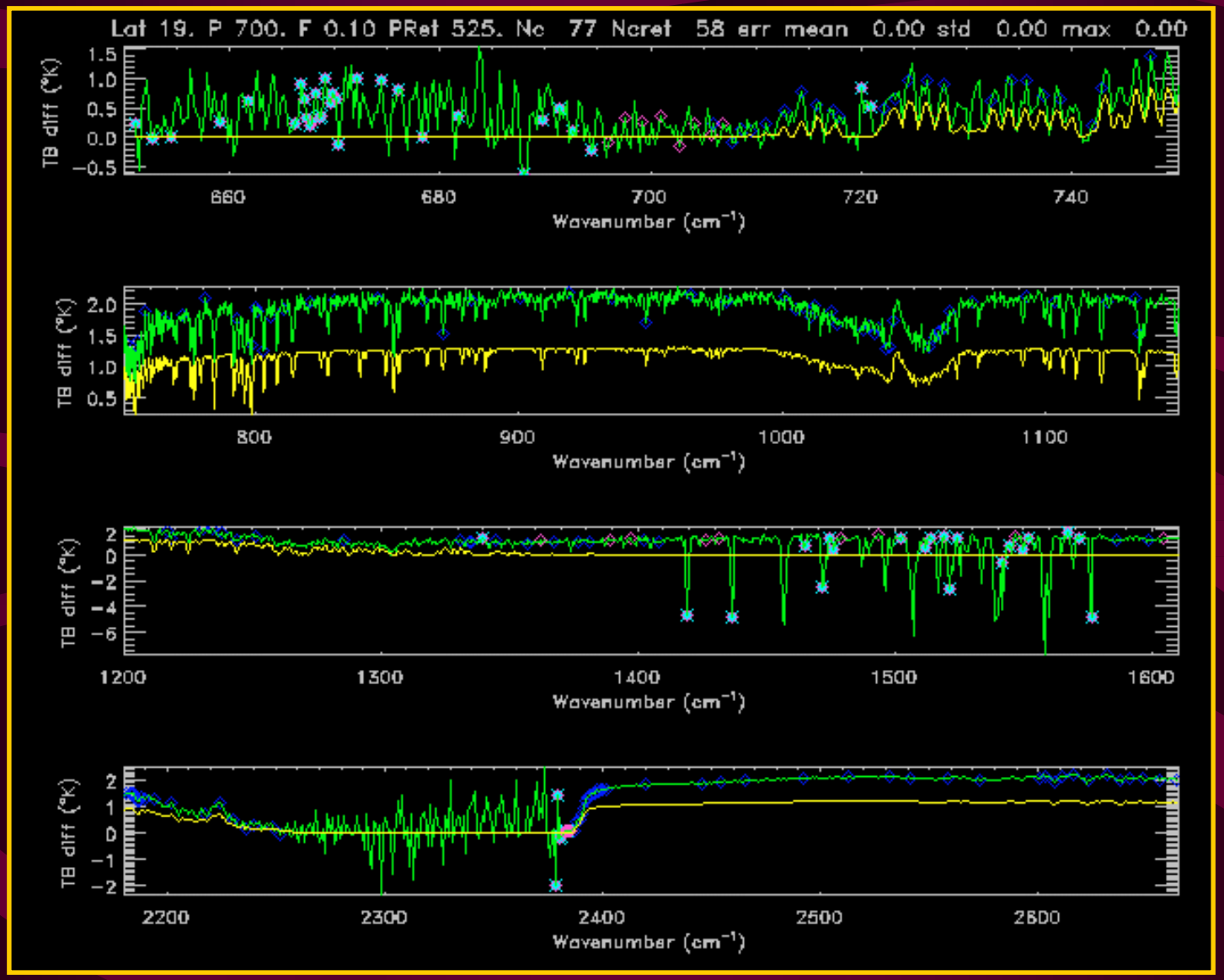

Summary and Future Work

- DAOTOVS 1DVAR has positive impact, especially on stratospheric temperatures; will be adapted for AIRS
- Cloud- and land-affected data has positive impact on forecasts (6hrs-5 days)
- DAO has variety of validation tools (O-F radiance-retrieval, QC monitoring, forecast-synoptic evaluation, etc.); will assimilate, evaluate AIRS team retrievals
- AIRS channel selection good for cloudy situations (sharp weighting functions; Dynamic channel selection in cloudy scenes, cloud slicing-like approaches worthwhile
- Prepare for AIRS with NCEP and NESDIS: e.g. OPTRAN, channel selection, cloud detection